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LUNAR AND PLANETARY LABORATORY

UNIVERSITY OF ARIZONA

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RESEARCH GRANT NO. NsG 161-61

Period 1 Dec. 1961 - 1 June 1962

I. Lunar Studies

a. The two editions of Part II of the Orthographic Atlas of the Moon came off the press December/January. Edition B, carrying the latitude-longitude grid as well as the orthographic grid, followed Edition A (orthographic grid only) by about one month. These issues complete the Orthographic Atlas, Part I having appeared about one year before. Eventually this Orthographic Atlas will be improved upon for the limb areas by the new measurements, now in progress; but it is not expected that significant revisions will be needed for the central areas. The atlas has already been widely quoted in contemporary lunar studies and combines the best information presently available on lunar coordinates with high-quality lunar photography. Five copies of Edition B were supplied to Dr. Smull on January 15, 1962 and six additional copies were sent to Mr. Carl B. Palmer on February 23, 1962, following instructions from Dr. Smull's office. Additional copies were supplied to JPL.

b. The preparation of the Rectified Lunar Atlas has proceeded, essentially, according to the plan presented before, though at a considerably slower pace. Difficulties developed from the fact that the depth of focus was initially quite limited both in the globe projection and in the subsequent photography. These difficulties were gradually reduced by optimizing distances and camera apertures. Most photography was carried out with the camera placed about 6 feet from the surface of the globe or 7½ feet from the center.

The final selection for the Atlas was based on detailed intercomparison of approximately 300 prints, 14 x 17 inches in size, of which 118 were selected for use. This includes from three to five

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pages of photographs for each of the 30 fields in which the visible lunar hemisphere was divided. Some of the plates are composites of two prints showing different areas of the illumination. This final selection was made April, 1962. The prints were mounted and scale factors were determined and entered, to insure that the final copying would be done to a uniform scale, selected at 1:3,500,000. Close liason with ACIC has been maintained on the format of the Atlas, nomenclature and notations, border notes, etc. ACIC now plans to issue their edition of the Rectified Lunar Atlas as a separate volume, not part of Vol. II (Supplement).

The photographic work on the Atlas, mostly by Mr. Spradley and an assistant, is now complete but the cartographic work on the gridded sheets will still take approximately 3 months. ACIC has agreed to do the engraving of the grids and nomenclature which will ensure professional appearance. Publication date for the Atlas is now expected early fall, 1962.

c. A condensed version of the Rectified Atlas, for the last quarter of the Moon only, was made in connection with the Ranger III and IV operations. This small atlas was copied at JPL and a limited distribution made on 8 x 10 inch prints.

d. Partly incidental to the preparation of the Rectified Lunar Atlas and the globe photography program a number of features of geophysical interest were discovered on the lunar surface by Mr. Hartmann and Dr. Kuiper. Among these are a dozen basins surrounded by two or more concentric rings. This has thrown new light on the early history of the moon. The results will appear as Communications of the Lunar and Planetary Laboratory No. 12, now in press. Preliminary work has also been done on covering systematically the lunar maria by rectified photography. A separate file of negatives on this work is being maintained, and will be published when complete.

e. A program of cartography of the limb areas of the moon, based on all available photography and supplemented by visual observations, was begun by Mr. Herring late fall, 1961, and is being continued. The program consists of the production of charts 30° in length each, measured along the lunar limb, so that the entire limb region is covered in twelve adjacent charts. Approximately half of this work was completed as of June, 1962. The results are reported in the Communications of the Lunar and Planetary Laboratory.

f. Two major catalogs have been in preparation under the direction of Mr. Arthur. One consists of a consolidated list of coordinated positions on the moon; the other of a list of measured crater diameters. The first catalog has gone to press. It consists of 183 pages of reduced positions for the 4,510 coordinated points on the lunar surface. It is followed by six appendices containing

explanatory notes, cross-references, corrections to previous lists of measures, etc. The entire catalog is about 220 pages. It will appear in Communications of the Lunar and Planetary Laboratory No. 11, early July, 1962.

The diameter catalog, comprising some 8,000 entries, is so bulky that it was decided to issue it in four installments, one for each quadrant of the visible hemisphere. The diameter measurements have been completed, with an average of 4 to 5 measurements on different plates per crater. The catalog for the first quadrant is being compiled for publication. The catalog includes, besides the measured diameters, information on the central peaks, on contacts or overlap with other craters, and other physical parameters. The catalog is complete down to approximately 2 miles diameter for the center of the lunar disc, with the limits somewhat relaxed near the limb. The precision is approximately one per cent for craters of medium size. The catalog will supersede all earlier work on the crater diameters which is of very uneven quality and in no sense complete. In the earlier work, errors of 10, 20, or even 30% were not uncommon.

g. The selenographic photography with the 40-inch Yerkes telescope is being continued. The total number of plates taken with this telescope now approaches 1700 of which 200-300 are of good to excellent quality and a total of approximately 600 are being retained in the LPL collection. Occasional photography at the McDonald Observatory also has continued when circumstances, such as unusual librations, warrant it. The McDonald collection now consists of approximately 700 plates, all of which are kept at LPL. Glass copies are available here of the Mt. Wilson and Lick photography and of the best of the Pic du Midi series.

h. Two series of selenodetic measurements are being carried out under Mr. Arthur's supervision. The first of the classical heliometer type, measuring the position of the bright crater Mösting A to the lunar limb, at 5° intervals in position angle. The measurements of this program are essentially complete, with somewhat over 30 plates having been measured. This program was designed in part as training for the assistants at the machine, and in part to get data needed for the prediction of times of lunar occultations. The main program is concerned with the measurements of 420 selected base points scattered over the lunar surface. They are to be measured near full moon, with a maximum departure of two days, so that illumination differences will not affect the measured position. Since the assistants are still in training, the measurements of the second program have not been started, but the 420 base points have been selected. The training program has been utilized, incidentally, to provide controls on the coordinated points near the lunar limb, many of which were found to be in error or even non-existent. This program was necessary particularly in connection with the construction of coordinate grids for the Rectified Lunar Atlas in the

limb areas.

Mr. Arthur has continued his work on the theory of the physical librations of the moon. The previous work by Hayn and Koziel was carried out to four decimals only, which is no longer adequate in view of modern precision of measurement. Mr. Arthur's work is carried out with two additional decimals. This means that a large number of additional terms must be included in the series developments.

i. Attention is called to the work done by Mr. Ewen Whitaker who has made an independent evaluation of the Russian photography of the reverse side of the moon. The results of his study are being published in Communications of the Lunar and Planetary Laboratory No. 13, and have been written up in shorter form elsewhere (The Solar System, Vol. 4).

j. In close collaboration with JPL, preparations were made for two small programs in lunar photography, with the 82-inch telescope at McDonald and the 36-inch telescope at Steward Observatory, University of Arizona, directed to gether the information on the possible impact of Ranger IV. This equipment will be available for similar subsequent events.

k. Dr. Kuiper served as Experimentor on the Ranger and Surveyor series and made a number of trips to JPL in this connection. He also carried out a special assignment for Mr. N. W. Cunningham, director of the Ranger Program.

II. Planetary and Laboratory Studies

Excellent infrared spectra of Venus have been obtained by Dr. Kuiper and assistants with the 36-inch telescope of the Kitt Peak National Observatory. The series includes solar comparison spectra taken at the same observatory with similar amounts of water vapor in the atmosphere. The results are being worked up for publication and will be reported on during the Symposium on Planets at Liége, Belgium, July, 1962. The region covered is 1.0 to 2.5 μ. Earlier, infrared spectra were obtained of the planet Jupiter, covering the region 1.0 to 1.9 μ. Infrared stellar spectra with the same spectrometer during two sessions at McDonald Observatory, in December and March 1962. Many new, unidentified features had been found in the cooler stars. Laboratory work is being organized by Dr. Meinel and students for the identification of these features. They involve the production of molecular emissions spectra; the exciting mechanism used is 14MC radiation.

III. Publications

Publications during the six-month period include Editions A and B of the Orthographic Lunar Atlas, as reported above and Communications Nos. 1-6 of the Lunar and Planetary Laboratory. Communications Nos. 7-13 have gone to press and copies will be supplied July, 1962.

The manuscripts of Communications 14 and 15 are complete except for final editing. Five other papers are in preparation. The list of titles of Communications 1-18, as revised, is appended.

Related to these activities, though not sponsored by the NASA grant, is the editorial work carried out by Miss Middlehurst and Mr. Kuiper. Volume III of the Solar System, Planets and Satellites, a book of 600 pages, appeared December, 1961. This volume contains 18 chapters, one, on the limits of completeness of solar system surveys, by Mr. Kuiper. Volume IV of the Solar System, entitled "The Moon, Meteorites, and Comets", has gone to press and is due to appear late 1962. Copies of the table of contents are appended. A fifth volume, on planets and interplanetary medium, is in preparation.

IV. Facilities

A new building for the Lunar and Planetary Laboratory, having about 8,000 square feet of laboratory and office space, is under construction and is scheduled for completion by mid-August, 1962.

A list of the telescopes, under construction or in design, was given in the previous report. This list still applies at present. The 21-inch telescope has been completed and has been accepted. No final decision on the dome and its installation have been made but arrangements are expected to be completed by July 15, 1962, with the installation expected to be finished by about September 15. It has been decided to proceed with the design and construction of the 10-ft. infrared telescope and the actual work is expected to begin shortly.

V. Staff

There have been no major changes in the staff since the listing in the last report.

VI. Concluding Remarks

With this report, the Lunar and Planetary Laboratory will have completed 20 months of operation. As stated in Communication No. 1, the Laboratory was to be concerned with (1) research; (2) publication of major collections of scientific records; (3) graduate instruction and Ph.D. programs. It is believed that the Laboratory now possesses a collection of lunar photographs that is more complete and is of higher quality than any other existing collection. The Rectified Lunar Atlas, and such special studies of the lunar surface as Communication No. 12 (containing 77 large plates), have heavily depended on the Yerkes and McDonald series of this collection. The full utilization of this NASA sponsored collection, which is still being extended, is far from complete. Studies of the Lunar Maria, the lunar grooves or grid system, the crater rays, the slopes on the maria, and the determination of a more precise selenodetic network are to be taken up next.

Gerard P. Kuiper

COMMUNICATIONS

Of The

LUNAR AND PLANETARY LABORATORY

Shipped

To be shipped July

COMMUNICATIONS

Of The

LUNAR AND PLANETARY LABORATORY

THE SOLAR SYSTEM, Volume IV

The Moon, Meteorites, and Comets

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